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A TREATISE

ON

PRUNING FOREST AND ORNAMENTAL TREES.

. . . "If the forests should disappear, civilization would become extinguished on the earth. . . .

"It is the duty of an enlightened community to plant trees, and to so care for them that posterity shall not suffer, — a duty unfortunately too little regarded in our day." — DECAISNE.

PUBLICATIONS

OF THE

Massachusetts Society for the Promotion of Agriculture.

A TREATISE

ON

PRUNING FOREST AND ORNAMENTAL TREES.

By A. DES CARS.

TRANSLATED FROM THE SEVENTH FRENCH EDITION.

With an Introduction

By CHARLES S. SARGENT,

PROFESSOR OF ARBORICULTURE IN HARVARD COLLEGE.

FIFTH EDITION.

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By Charles S. Sargent.

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INTRODUCTION

TO THE

AMERICAN EDITION.

THE Trustees of the Massachusetts Society for the Promotion of Agriculture have intrusted me with the preparation of an American edition of the Count des Cars' treatise on Pruning Forest Trees.

No comprehensive work on this subject has appeared before in the English language. This, perhaps, is not remarkable. In Great Britain the earlier plantations, largely inspired by the works of Evelyn, were made with the view of ornamenting private parks, and the question of increasing the individual capacity of trees to produce timber by any system of pruning was hardly considered. The economic plantations of later years, made in Scotland and afterwards in England, have been generally composed of coniferous species, which, when properly planted, largely prune themselves. In America we have been too busy devising methods for cutting down our forests to give serious consideration to other branches of forest economy; and the American people have yet to show whether they can ever replace the magnificent tree-covering

their ancestors found on this continent, and which they are now too rapidly and surely destroying.

The advantage of pruning forest trees, in order to increase their yield of timber, was recognized in Germany as early as the beginning of the seventeenth century. At first warmly advocated, the practice seems to have been soon very generally abandoned; and it was not until the writings of de Courval and des Cars, recommending a scientific system based on fundamental laws of vegetable physiology, again called public attention to the importance of the subject, that systematic pruning became a regular operation in all Continental forests.[1]

Their system is based on the fact that, as wood is alone formed by descending, elaborated sap, a wound

[1] The following are the most important works which have been published on this subject: —

Grundsätze der Forst-Œconomie. Moser. 1775.
Anleitung zur sicheren Erzielung der heimischen und fremden Holzarten. Burgsdorf. 1785.
Lehrbuch für Förster. Hartig. 1811.
Behandlung und Schatzung des Mittelwaldes. Pfeil. 1830.
Theory and Practice of Horticulture, Chap. XIII. Lindley. 1855.
Taille et Conduite des Arbres Forestiers. De Courval. 1861.
L'Elagage des Arbres. Des Cars. 1864.
Anleitung zum nationellen Betrieb der Ausästung. Von Muhlen. 1873.
Forstliches Halfsbuch für Schule und Praxis. Pressler. 1872.
Schneiden und Ausästen. Tramnitz. 1873.
Sämen und Pflanzen. Burckhard. 1874.
Das Ausästen der Waldbäume. Vitus Ratzka. 1874.
Ueber die Folgen ausseren Verletzungen der Bäume. Goeppert. 1874.
Notice sur l'Elagage des Arbres, by Martinet. Published by the Administration of the French Forests in connection with the national exhibition of forest products at the Paris Exposition of 1878, — a valuable paper to which I am indebted for much information.

made on a tree can only be recovered with healthy, new wood, when its entire circumference is brought into direct communication with the leaves by means of the layer of young and growing cells formed between the wood and the bark. To make this connection it is necessary to prune in such a manner that no portion of an amputated or dead branch shall be left on the trunk. The cut should always be made close to and perfectly even with the outline of the trunk without regard to the size of the wound thus made. This is the essential rule in all pruning, and on its observance the success of the operation depends.

It is not probable that the practice of pruning forest trees will be generally adopted in the United States until the further destruction of our forests has carried the cost of forest products to a point where it will be profitable to plant and rear in this country new forests according to scientific methods. That time cannot be far distant; and already many of our special industries dependent on certain hard woods feel the want of better and more abundant material. Some attention, especially in the Prairie States, has of late years been given to tree-planting, and large and successful plantations already exist in many parts of the country. The value of such plantations can be greatly increased by the early adoption of a scientific system of pruning, which, if applied also to the valuable hard-wood trees scattered over the more thickly populated portions of the country, could not fail to largely increase their productive capacity.

The climate of the United States renders it desirable that our highways should be bordered with trees.[1] They are necessary to protect the traveller from the cold winds of winter and the excessive heat of the summer sun. This necessity is recognized; and city and roadside trees are everywhere planted. Such plantations, however, too often suffer from total neglect, or from injurious systems of pruning, which shorten rather than prolong the lives of trees, and diminish their usefulness and beauty.

Des Cars' method of pruning might well be adopted by all persons in charge of highway plantations; and the advantage of such a system being thus demonstrated, its general application to purely economic plantations, and to the timber trees scattered over the country, will naturally follow.

C. S. SARGENT.

BROOKLINE, 1881.

[1] The importance of following in all street and roadside planting the rule which requires that every connected street must be planted with a single variety of tree should be insisted on. This plan is universally adopted in Europe, and its advantages over that which mixes various trees widely differing in habit, rapidity of growth, and longevity in the same street plantation, are very great. This will be seen by comparing the effect produced by the rows of Elms on the Mall in Central Park, or by the magnificent avenues of Live-oaks near Savannah, and on Cumberland Island, Georgia, with the mixed plantations too often seen in this country, and in which alternating Elms and Maples form a favorite combination.

PREFACE TO THE FRENCH EDITION.

I HAVE no claim to originality in this work, and my only object in its publication is to popularize de Courval's method of pruning, in order that all owners of rural property may increase the value of their trees in a simple, sure, and inexpensive manner, through a system of rational pruning.

M. de Courval first laid down the principles on which the system I recommend is based; and this little treatise is by no means intended to take the place of his larger work, which I cordially recommend to every one interested in forest management.

I acknowledge the priority of M. de Courval's publication, and consider it an honor to follow in his footsteps; although I am alone responsible for the system I recommend, which has, moreover, been reached through my own investigations and experiments.

The illustrations scattered through the text have been drawn from nature and have one merit, — that of correctness.

A. DES CARS.

PROFESSOR J. DECAISNE, *Member of the Institute, Director of the Gardens of the Museum of Natural History, Paris.*

MY DEAR SIR, — In your learned and brilliant address delivered at the Museum the thirtieth of April last, you sanctioned the method of pruning practised with perfect success for more than forty years by M. de Courval in the forests of his vast estate of Pinon (Aisne).

M. de Courval has detailed his methods in a work[1] of great interest and value, but too technical, and too expensive perhaps, for general use. Having been long occupied in the study of this important subject, I prepared, several years ago, a purely practical treatise on pruning, almost identical in its conclusions with the more elaborate work of M. de Courval, although entirely based on my own observations and experiments.

Your encouragement and the desire of M. de Courval have decided me to publish, almost in its original form, this treatise. It has been used by a few practical foresters, a class for which it is intended, although containing certain general considerations to which I desire to call the attention of all interested in sylviculture.

The authority which you give me to place your name on this page is the best guarantee I can offer to the public that the system my humble production explains is based on true scientific principles; and your name will contribute more than any other to the success of my efforts to preserve and develop an important and neglected source of the national wealth.

A. DES CARS.

PARIS, June, 1864.

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[1] *Taille et conduite des arbres forestiers et autres arbres de grande dimension, ou Nouvelle méthode de traitement des arbres à haute tige*, etc. Paris, 1861.

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TREE PRUNING.

TREE PRUNING.

CHAPTER I.

GENERAL CONSIDERATIONS.

THE appearance of many trees, their trunks covered with gaping wounds, protuberances, and the stumps of dead branches, clearly indicates that they have received careless or ignorant treatment. It is evident even to persons little familiar with the art of Sylviculture that such trees are decayed to the heart, and of little value for industrial purposes. The number of trees thus affected is very great, and the annual aggregate loss to the community from the bad management to which trees are everywhere subjected is enormous. Such a condition is the result generally of entire neglect of pruning, or often, perhaps, of an unnatural and therefore improper system.

The idea of increasing the productive capacity of forests by systematic pruning is not a new one, — no process of Sylviculture has been more often discussed. In Belgium, where more than in any other country

the subject of forest management has occupied the public mind, the two legislative chambers, a few years ago, discussed this subject at great length without reaching any satisfactory conclusion; in France, authorities do not yet agree, — some condemn all pruning, while others believe in the advantage of pruning, but without agreeing on the best methods to adopt.

Certain theorists declare that there is an absolute correlation between the roots and the branches of a tree, and that the cutting off of a branch necessarily kills the corresponding root. If such a theory is correct, how can the results obtained by cutting back young trees to the ground or the topping of pollards, by which all branches are suppressed, be explained?

A more serious objection to pruning, which is often made by timber dealers, — the persons, perhaps, most interested in the matter, and therefore most competent to judge, — is that trees which have been pruned lose by the operation twenty-five, thirty, or even fifty per cent of their value, that is, a quarter to a half, and that such trees are generally decayed. This cannot be denied; but it proves that such trees have been badly pruned, — not that all pruning is bad. Opponents of pruning maintain, too, that the scars which such operations must leave on the trunks of trees indicate internal defects in the wood, and that these trees cannot be readily sold. This objection is also well founded in view of the manner in which the operations of pruning are generally performed; but

it is the method which is faulty, and such objections must disappear before more scientific and rational treatment.

A glance at Fig. 1 shows the effects of bad pruning. Here the trunk of a Beech is represented mutilated, and in a condition which might well justify the general condemnation of pruning, if pruning was always followed by such results.

Fig. 1. — Badly pruned Beech: its trunk covered with cavities of different depths and partly filled with water.

A system of forest management which discards pruning is disastrous, and, even if it were less so, would have many practical objections. A tree left entirely to itself generally develops in one of two directions. It does not grow upwards and assumes the low round form common to the apple-tree; the lower branches grow disproportionately large and absorb too much sap, to the detriment of the top of the tree; and these long, heavy branches are often broken by the wind or by snow and ice, leaving hideous stumps (Fig. 2). Trees of this form are very common; they generally decay at the top before reaching maturity, and have little commercial value. On the other hand, many vigorous trees grow disproportionately

at the top: the lower branches die from insufficient nourishment, fall off, and leave, when large, bare

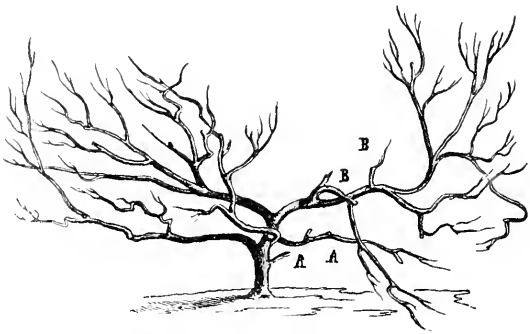

Fig. 2. — A young unpruned Oak growing in rich soil. A. Dead branches. B. Branches broken by the wind or by the weight of snow and ice.

decayed spots, which gradually penetrate to the heart of the tree, and ruin also its commercial value (Fig. 3).

Wounds caused by the breaking off of large branches by wind or snow produce the same results (Fig. 4). There is no remedy for the dangerous effects of such accidents except in pruning; it is a simple question of surgery. Without pruning, the tree must sooner or later decay; with pruning, its value may be preserved.

The secret of obtaining a complete cure in all operations requiring the removal of a branch, either living or dead, consists *in cutting close to, and perfectly even with, the trunk.* Many authorities have hinted at this, the cardinal principle of all pruning; but M.

de Courval first clearly demonstrated its importance, while his discovery of the value of coal-tar or the refuse from gas-works as a covering for wounds made in pruning renders the application of his rule in all cases entirely safe.

Fig. 3. — Portion of the trunk of an unpruned Oak ruined by the decay of its lower branches.

Formation of Wood. — The reason that a branch should be cut close and even with the trunk is found in one of the simple laws of plant life. It is known that sap has a double movement, — that it mounts from the roots to the leaves, and returns again in an elaborated condition to the roots. Roots take up water from the soil in which there are various salts in solution. This water rises to the leaves; these absorb from the air and decompose carbonic acid gas, the basis of which is carbon, which combined with water constitutes the elements of wood. The sap thus elaborated by the leaves is carried down again in a liquid state and is deposited, year after year, in the successive concentric layers of wood which form the trunks of all trees, with the exception of Palms, Yuccas, &c., which need not now be considered.

It follows that a wound caused by the amputation of a branch must, in order to heal properly, be made perfectly even with the trunk, that every part of its outer edge may be brought into direct communication with the leaves through the network of cells destined to convey the descending sap. Although this theory rests on one of the most elementary principles of vegetable physiology, it has not been applied before to practical forest management. The amputation having been made even with the trunk in the manner explained, new wood will soon appear, forming first round the top and sides of the wound, which is soon completely surrounded by the new growth; the wound is gradually healed over, and the decay of the trunk prevented. The time required for the complete healing of a wound depends, of course, upon its dimensions and the natural vigor of the tree.

Fig. 4. — Unpruned Oak, decaying after the loss of a large branch broken by the wind.

The principle being established that large wounds can be made without injury to the tree if care is taken in the manner indicated to prevent decay, it is easy to show the advantage of cutting off injured branches of any size. It is preferable to avoid, of course, the necessity of making large wounds by properly pruning trees when young. All foresters agree that trees should be trained when young, but

de Courval has amply demonstrated by numerous remarkable specimens exhibited at the Agricultural Show of Paris, in 1861, and at the Universal Exposition of London, in 1862, that it is beneficial, and often indispensable, to prune the oldest trees if care and judgment are used in the operation. He has clearly shown, too, that trunks so treated attained a larger size and a greater value in a given time than those which, under similar conditions of growth, had been allowed to retain all their badly placed branches. I regret in this connection to differ from so eminent an authority as de Breuil, who gives the following rule: "Amputations must be performed in such a manner that the diameter of the wound shall not exceed that of the end of the branch." Such a practice must, I believe, be disastrous, for whenever a branch of large size is amputated in this way, it is evident that a cavity in the trunk of the tree will sooner or later appear.

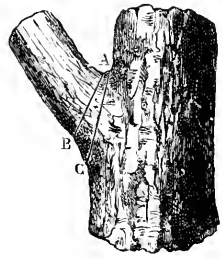

Fig. 5.

Disadvantages of the Common System of Pruning. — As descending sap alone forms the new bark and wood which heal over a wound, it follows that, if a cut is made in the manner represented by the line A B (Fig. 5), the new growth cannot cover over the lower part, B C, which is cut off from communication with the leaves; so that the wood included in the lines A B, A C, not being covered

with a new growth must soon begin to decay, and in time destroy the trunk of the tree (Fig. 6). Examples of this bad method are very common. Each amputation of a branch produces a cavity, and the tree soon becomes entirely decayed. In view of such destruction, it might seem, perhaps, that branches of a certain diameter cannot be safely amputated. That this is an erroneous idea will be easily seen ; and it is only necessary to make the amputation even with the trunk, and then cover the wound with coal tar to avoid all bad results. Although wounds caused by the amputation of small branches heal over in spite of the faulty methods of pruning generally employed, such operations are, nevertheless, attended with considerable danger to the tree. Protuberances are formed on the trunk at the points where the branches have been cut, and these produce a multitude of small weak shoots (A, Fig. 7). The development of such shoots indicates that a tree is in an unnatural condition, which may be entirely avoided by cutting the branch even with the trunk (B, Fig. 7).

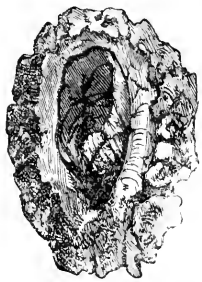

Fig. 6. — Decaying Oak, showing the effect of amputating a branch in such a way that the diameter of the wound does not exceed the diameter of the base of the branch.

Experience and common-sense show the objection to leaving any portion of an amputated limb, but there is greater danger in allowing stumps one or two feet long to remain on the trunk, a common

practice even among persons interested in the preservation of trees (Fig. 8).

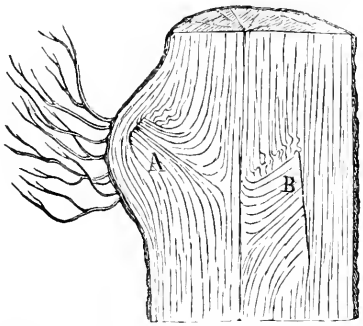

Fig. 7. — Longitudinal section of the trunk of an Oak cut twenty years after pruning. A. A medium-sized branch badly amputated. B. A large branch properly amputated

These stumps, deprived of communication with the leaves, die, the bark falls off, while the stumps themselves remain like plugs of decaying wood driven into the trunk (Fig. 9).

In a few years the stumps rot (Fig. 10), and decay penetrates to the heart of the tree. Fig. 11 shows the fatal results of this method of pruning.

Fig. 8. — Stump of a branch left in pruning.

The method of pruning deciduous forest trees, and especially the Oak, will be first considered in this treatise. The Oak is selected as the most valuable of our timber trees, and because unfortunate and deeply rooted prejudices exist in

regard to the manner in which it should be pruned. Particular attention will be given to the treatment of trees intended to grow on to maturity, in connection with a system of coppice growth, because this system of forest management is now very generally adopted.[1] The methods here advocated are, however, equally applicable to other systems of sylviculture; and they should interest small as well as large land owners, as in every field and along every roadside are trees to prune and improve. If the importance of properly caring for trees could be appreciated, an important addition to the wealth of the nation might easily be made. Oaks, stunted or abandoned, and only fit for fuel, might in a few years be transformed into trees of great value; and, if all who prune may not themselves find their reward, they can at least have the satisfaction of doing something to benefit another generation.

Fig. 9. — Condition of the stump at the end of the fifth year.

[1] *Futaie sur taillis*, a term which is without equivalent in the English language, is applied in France to a very common system of forest management. It consists in allowing a certain number of selected trees in a plantation to grow to maturity, while the remainder is treated as coppice, or "sprout land," and cut over at stated periods, varying from ten to fifty years, according to the nature of the soil or the necessity or wishes of the proprietor. The trees left to reach maturity are called "reserves," and are intended to furnish large timber for purposes of construction. These, of course, receive the greatest care and most careful pruning. C. S. S.

Advantage of increasing the Number of Reserve Trees. — In addition to the advantages which each individual tree may derive from the method of pruning recommended in this treatise, there is a possibility of adding, and, in fact, doubling the number of reserve trees in a plantation without interfering with the coppice or growing sprouts which surround them.

Fig. 10. — Condition of the stump at the end of the tenth year.

If it can be proved that the number of timber trees may be doubled in a plantation by good management, and that the value of individual trees scattered through the fields and along the roadsides may be wonderfully increased, it is easy to understand that a land-owner may greatly benefit himself and add to the wealth of his country by adopting such methods.

Fig. 11. — Trunk of an Oak ruined by the decay of the stump of a branch.

That pruning can accomplish the results which are claimed for it is found in the fact that trees treated by the rational system proposed grow more vigorously and retain their foliage longer than unpruned trees in the same locality grown under similar conditions.

Authorities agree on the influence which trees exert on the climate, the watercourses and the fertility of the soil. Economically indispensable trees are not less important in their influence on the health of man. Trees purify the air we breathe by absorbing noxious gases, and it is clearly for the interest of the community to preserve and multiply the forests, which protect the human race from many evils.

CHAPTER II.

GOOD PRUNING. — ITS AIMS AND METHODS. — DIVISION BY AGE OF RESERVE TREES INTO FOUR CLASSES.

Aim and Method of Pruning. — The object of pruning, economically considered, is to make it possible to raise on a given surface, say on one hundred acres of sprout land, the greatest number of full-grown trees, and to make them attain the greatest value in the shortest time without injury to the young trees beneath them. This may be accomplished by increasing the vigor of the reserve trees and by lengthening, without diminishing in diameter, their trunks. Treated in this manner the reserve trees do not interfere with the circulation of air and light necessary to the development of the undergrowth; and many serious accidents caused to trees by wind, frost, and snow breaking the larger branches may be avoided by keeping their heads symmetrical and upright.

The perfect forest tree has a straight, single trunk without protuberances or wounds, and carrying up the same diameter to the first branches, which should

be placed at a distance from the ground equal to one-third or one-half of the total height of the tree. The head should be rounded, regular, and set upright on the trunk. The wood, owing to the healthy growth of the tree, is straight-grained, compact, and suitable for construction. Such trees have a high value; and, in order to grow them, a method of pruning is adopted similar to that practised by gardeners in forming pyramidal fruit trees, with the difference, however, that the gardener favors the development of the lower branches, which are necessary for his purpose, while the aim of the forester is to increase foliage at the top of the tree by diminishing the vigor of the lower branches; and to obtain by successive suppressions of branches the necessary length of trunk.

There are two distinct operations in pruning: the removal of some branches, the shortening of others. The shape of a tree must depend somewhat, of course, upon its age, the nature of its surroundings, and the character of the soil, etc. Where pruning is not practised the reserve trees approach the proper form in proportion to the length of time the coppice beneath them is allowed to grow. In forests, where thirty or more years are allowed to elapse between the cuttings, the undergrowth serves to prune the permanent trees by checking the development of their lower branches, and thus determining the height of their trunks. Sprout land is, however, often cut over every ten years; and this practice prevents the

production of fine trees by permitting the growth of their lower branches. These, of course, interfere with the growth of the reserve trees themselves as well as with the young trees between them. Judicious pruning can obviate this difficulty.

Classification of Forest Trees according to Age. — The technical names by which reserve trees are known vary in different regions. For our purpose it will be best to divide the life of a forest tree into four principal periods, designated as follows : —

1. Young, up to about forty years.
2. Middle-aged, from forty to eighty years.
3. Old, from eighty to one hundred and fifty years.
4. Very old trees, whose number is rapidly diminishing, may be called Veterans.[1]

These divisions are not, of course, absolute, as it is often difficult to determine, even approximately, the age of a standing tree ; and the forester must use considerable judgment in the application of the following rules : —

1. The head of the young tree should be egg-shaped or elongated oval (Fig. 12), and well balanced

[1] The technical terms employed in France to designate trees of the four classes into which forest trees are generally divided, *Baliveau, Moderne, Ancien, and Vieilles écorces*, have no equivalent as yet, and are not well translated into English. The term " Baliveau " is also sometimes applied to reserve trees of any age left after the first cutting off of a plantation, and such trees are then called " Modernes " or " Anciens," according as they have been allowed to remain after a second or third cutting of the coppice. C. S. S.

on the trunk, which should not exceed a third of the entire height of the tree. The lower branches should

Fig. 12. — Correct form of head for a tree under forty years old.

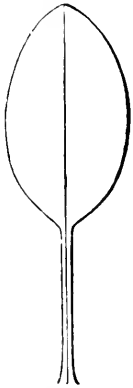

Fig. 13. — Correct form of head for a tree forty to eighty years old.

be sufficiently shortened to check their excessive growth at the expense of the leader, without, however, being so reduced as to impair the vigor of growth of the tree.

2. The head of the middle-aged tree should form an oval less elongated than that necessary for trees of the first class. The height of the trunk should equal one-third to two-fifths of the height of the tree (Fig. 13).

3. The head of the old tree (Fig. 14) should be gradually rounded in outline; the trunk may, in some cases, be made to reach a height equal to half the height of the tree, which has now probably ceased to grow upwards.

4. Veterans (Fig. 15). Trees classed as veterans have generally ceased to increase in size. They

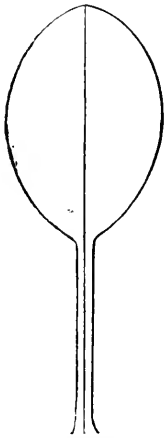

Fig. 14. — Correct form of head for a tree eighty to one hundred and fifty years old.

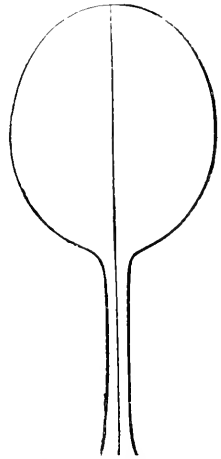

Fig. 15. — Correct form of head for a very old tree.

gradually become flat-headed, and spread out, without, however, greatly injuring the adjoining coppices and plantations destined to take their place.

The proper method of pruning trees in each of these four divisions will be considered hereafter.

It is well to remember that the forms recommended are those nature gives the most perfect and most beautiful trees; although it is the economic and not the picturesque aspect of trees which is here under consideration.

CHAPTER III.

APPLICATION OF THE SYSTEM.

Tools used in Pruning. — The most convenient tool for pruning is a straight-bladed cleaving knife. Success in all operations of pruning depends on the neatness of the cut, and this cannot be attained with the common billhook used in many parts of France. The best tool for the purpose is (Fig. 16) one which has been used for many years in Holland, and which has lately been improved by de Courval. It weighs from 2 lbs. 12 oz. to 3 lbs. 6 oz., or more, according to the strength of the workman. The blade is reinforced in the middle to increase its strength and concentrate the weight. In the north of France this tool is generally hung to an iron hook (Fig. 17) attached to a leather strap buckled round the workman's waist, who is thus left perfectly free in his movements (Fig. 18).

Fig. 16. — Improved pruning knife. Entire length, sixteen inches.

Fig. 17. — Iron hook used in attaching the pruning knife to the belt.

In pruning tall trees, or trees otherwise difficult to climb, the leather belt may with advantage be passed over the shoulder, thus bringing the pruning

knife under the arm in a position from which it cannot easily be dislodged in climbing (Fig. 19). To insure greater safety in climbing tall trees, a stout cord attached to the workman's waist may be fastened round the trunk in such a manner as to prevent, in case of accident, a dangerous fall. A hatchet is use-

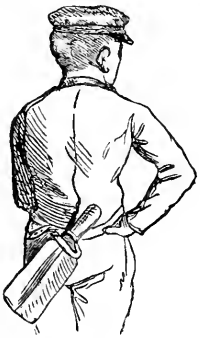

Fig. 18. — Pruning knife carried at the waist.

Fig. 19. — Pruning knife carried under the arm.

ful, and facilitates the operation of pruning ; it may be used with one or both hands, and serves to lop off large branches, protuberances on the trunk, or the dead stumps of branches, which from their hardness would soon dull the edge of the best pruning knife. A saw, too, is very useful in cutting large branches, but it requires so much practice to use this tool skilfully that it cannot be generally recommended.

Ladders. — Each laborer should be equipped with a light ladder, proportionate to the height of the tree on which he is to operate, and broader at the base than at the top. De Courval recommends that the

feet of ladders intended for this purpose should be pointed to prevent them from slipping. This is a good plan, although hardly sufficient to prevent accident, and the top of the ladder should be fastened with a strong rope to the trunk of the tree to prevent it from being thrown down by falling branches (Fig. 20).

Hooks or Spurs. — Except in very exceptional cases, or where very large trees are to be operated on, the climbing spurs sometimes used by professional pruners should not be allowed. These men, paid according to the number of trees operated on or the quantity of wood cut, have no idea in pruning beyond cutting the largest amount of wood in the shortest time. Climbing spurs should never be used by good workmen even, in pruning young trees, whose bark is not sufficiently thick to resist the wounds caused by the sharp iron teeth of this tool. Wounds made in this way encourage the growth of injurious side shoots on the trunk, and leave defects in the wood which never disappear, and diminish its value.

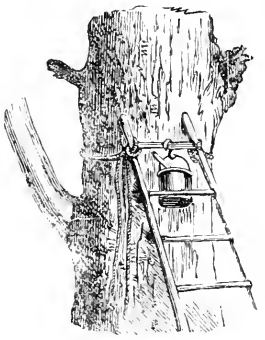

Fig. 20. — Ladder fastened with a rope and carrying on the top-round the pail of coal-tar.

The future value of a tree depends upon the manner in which the operation of pruning has been performed; and the persons to whom this work is

intrusted should fully understand its importance. Unskilful or injudicious pruning may completely ruin a tree, and the difficulty of obtaining labor capable of doing such work intelligently causes, no doubt, many arboriculturists to completely neglect pruning of every kind.

The Dendroscope. — The tree requiring pruning should be carefully studied from the ground, that the operator may be able to judge intelligently which branches should be removed or shortened in order to reduce it to the desired shape. This may at first seem difficult to beginners in the art of pruning; and a dendroscope, the name suggested for a simple little contrivance, the use of which is shown at Fig. 21, may be here used with advantage. A dendroscope may be made from a piece of thin board or card-board (a playing card answers the purpose), in which a hole of the shape it is desired to reduce the tree to has been cut (see Figs. 12, 13, 14, 15). Across the middle of the hole, from top to bottom, a piece of fine wire is stretched to serve as a guide to the eye.

Holding the dendroscope at the level of the eye, with the wire opposite the centre of the trunk of the tree to be studied, the operator approaches the tree until the bottom of the cut falls on the trunk at the ground line. It is easy to see at a glance with the aid of this contrivance what operations should be performed in order to reduce the tree to the desired shape.

Remembering that under ordinary circumstances, a vigorous, handsome tree must have a straight, vertical trunk and an evenly balanced head, the first

Fig. 21. — Manner of using the dendroscope.

object of pruning should be to produce these conditions. The head, as has already been explained, should be oval in form; the height of this, however,

must depend on the size of the trunk and the age of the tree when first subjected to the operations of pruning.

Selection of the Leader.—The branch most nearly perpendicular on the trunk of the tree should be selected to form the leader; and it may be stated as an absolute rule, that *whenever a branch near the top of the tree stands vertically on the trunk, or even on any part of the trunk, it should be preserved for the leader* (Fig. 22).

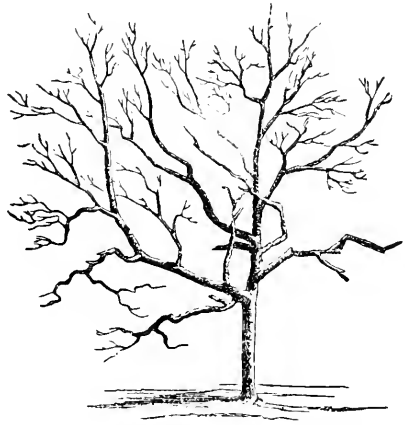

Fig. 22.—Oak sixty years old. Formation of a leader from a vertical branch.

And it is wrong to suppose that only the original leader can be used. Its place may be often supplied by one of the lateral branches even; and by shortening the other branches to stimulate the growth of the new leader, the tree will, in a few years, straighten up in a manner which will appear astonishing to persons

unfamiliar with the results which may be obtained from a sensible system of pruning.

If none of the branches near the top of the tree naturally approach a vertical position, two or three or several branches should be preserved to form a compact head, as represented in Fig. 23. If the tree so

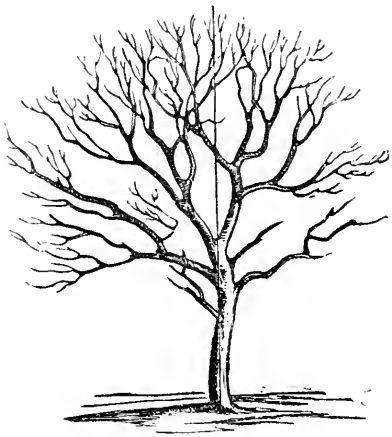

Fig. 23. — Oak with irregular head formed with several large branches.

treated is young, it is desirable, if possible, to establish the fork at a distance from the ground equal to at least one third of the height which the tree may be expected to attain at maturity.

Shortening Main Branches. — Starting from the top of the tree, where the operation of pruning should always begin, the leader is first formed with the branch selected for this purpose ; the head is made with a single leader ; or, in case of necessity (Fig. 23), with several leaders. The principal branches, if

too long, should then be shortened, especially those inclined to assume a vertical position or to grow with too great vigor at the expense of the leader; such branches are called gourmands. It will be seen that the right point at which to shorten these vertical branches is the point where they begin to assume an upright growth (A and B, Fig. 24).

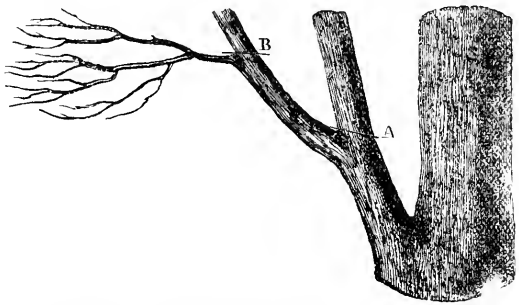

Fig. 24. — Double shortening of a main branch. A. Gourmand branch. B. Secondary branch. C. Small branch retained to insure a proper flow of sap.

In shortening branches, the cut should, if possible, be made above the point of development of one or several secondary ascending branches; these in turn should also be cut just above one of their secondary branches. In this way the direction of the main branch may be entirely changed (Fig. 24), and its disproportionate vigor checked to the benefit of the leader and the whole tree.

Sap Lifters. — The name of sap lifter [1] may, for want of a better term, be given to the branch or branches retained at the end of the shortened main branch.

[1] Branche d'appel.

The name indicates the object for which such branches are left; namely, to attract and elaborate, by means

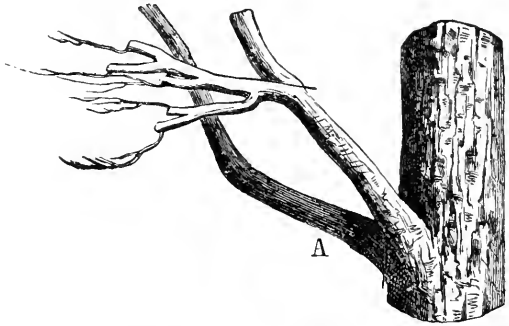

Fig. 25. — Removal of a portion of a forking branch. A. Preservation of a horizontal fork at the end of a shortened branch.

of their leaves, a sufficient flow of sap to insure the growth of the branch. Sometimes the main branches are so long that it is impossible for the operator to reach the ends where the sap-lifting branchlets should, of course, be left. In the case of the Oak, such branches, except for the appearance of the tree, are of little importance; and provided the main branch retained is of a certain length (ten or twelve feet), and if it is large and on a large healthy tree, a sufficient number of new shoots to insure vigorous growth will soon appear. With the Beech, however, and some other trees which do not develop shoots from dormant buds as freely as the Oak, it is necessary to cut the branch just above the forking of another branch or branchlet large enough to attract sufficient sap to insure a healthy growth.

Double or Forking Branches. — In the case of a double branch, or of a branch forking close to the trunk of the tree, one of these branches (Fig. 25) should always be removed, that the base of the branch may not become disproportionately large. If, however, such double branches are objectionable near the trunk of the tree, they are of great importance at the extremities of main branches; and whenever it is possible, branches should be shortened in such a manner as to secure forking branchlets at their ends. These give to the tree a more natural appearance, and by dividing the flow of sap prevent the growth of too vigorous shoots, which might in time develop into supplementary leaders, to the injury of the tree. For this reason it is necessary to remove all branches or branchlets assuming a vertical growth or inserted on the upper side of a shortened branch, in order to check the tendency of such branches to grow too vigorously at the expense of the leader (Fig. 26).

Although essential in pruning young trees, this is less important in the case of older trees with large full heads, which in themselves have a tendency to check an unnaturally strong growth of any individual branch; and, in operating on old trees, the preservation of vigor in the shortened branch is the principal object to be attained. It is almost unnecessary to add that only main branches directed towards the outside of the tree should be preserved, and that branches which from any cause have turned back towards the

trunk should be headed in, as well as branches with too great a tendency to droop unnaturally; generally,

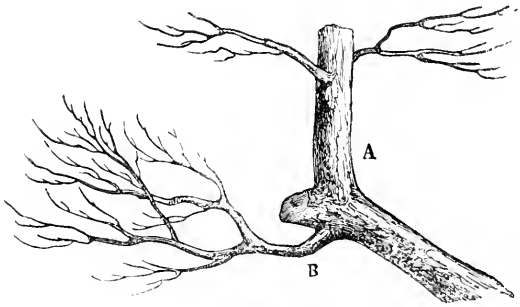

Fig. 26. — Effect of preserving a vertical secondary branch on the upper side of a shortened main branch. A. Branch thus retained, excessively developed at the expense of the rest of the tree. B. Sap lifter of the right size left on the lower side of the main branch to insure its development.

it will only be necessary to shorten such branches to induce them to reassume a natural direction of growth.

When several branches have been developed from one node, forming what botanists call a whorl, they should not all be cut away at the same time, lest the circulation of sap be checked by the destruction of bark (and consequently of cambium layer) over too large a surface.

All dead and dying wood should be removed by the workmen in descending the tree; lichens, and other parasites which interfere with the growth of young trees, should be knocked off with the back of the pruning knife; and the Mistletoe, the most destructive of all parasites to tree life, should be

carefully removed by cutting off the branch bearing it.[1]

The necessity of commencing the operation of pruning at the top of the tree must be insisted on; in no other way can the form proper to the tree be established or the safety of the operator preserved. The disregard of this rule was followed not long ago by what might have been a severe accident. An excellent workman was about finishing the pruning of

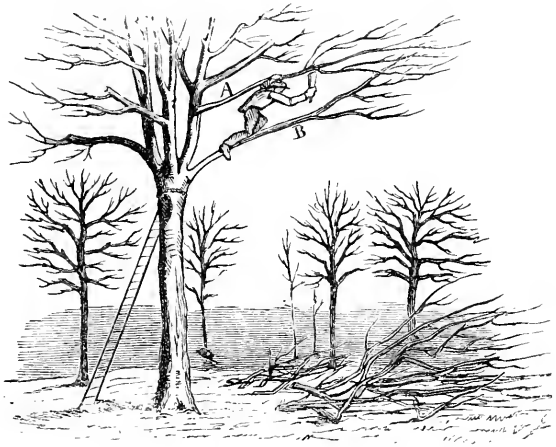

Fig. 27. — Pruning badly commenced.

a Beech tree; two long, slender branches (A and B, Fig. 27) remained to be operated on. He cut the

[1] In some portions of the United States where the American species of Mistletoe flourishes, especially in the Mississippi States south of the Ohio, great damage is done to different trees by this plant. The destruction of the Black Walnut from this cause has become very general, and causes serious loss in some portions of Kentucky and Tennessee. C. S. S.

lower of the two branches first; the twigs on the ends of the branches had become interlocked, and the branch B, in falling, pulled down the branch A. This broke under the weight of the first, and, striking the operator on the head, inflicted a severe wound, causing his fall to the ground, a distance of twenty or thirty feet.

The Amputation of Large Branches. — Many of the lower branches previously shortened must afterwards be removed, from time to time, until the necessary height of trunk has been attained. The number of branches to be removed must, of course, depend on the height of the tree, the nature of the soil in which it grows, and its age when first operated on. Great caution should be observed in amputating large branches; small branches can, of course, be lopped off at any time without danger to the tree. We agree with de Courval that at least three medium-sized branches may be safely removed from a tree in one year; although if the branches are very large, not more than one, or perhaps two, should be cut at one time. It is always desirable, however, not to unnecessarily increase by the removal of living branches the wounds left on the trunk by the cutting off of dead branches or other excrescences.

Whenever it is necessary to amputate a large or long branch, it should be cut first in such a manner as to leave a stump two or three feet long before the final operation of cutting it close to the trunk is undertaken (Fig. 28). In this way the danger of tearing

away by the weight of the falling branch portions of the bark of the trunk may be avoided. This will pre-

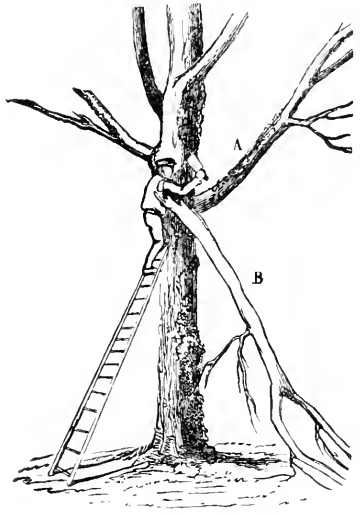

Fig. 28. — Danger of beginning the amputation of a long, heavy branch by a cut close to the trunk. A. Point at which the branch should be first cut. B. Branch badly cut; the butt striking the workman.

vent, too, the serious accidents which often occur when a large branch is cut at first close to the trunk, when the end striking the ground may cause the butt to fly up and throw down the workman. It is an indispensable condition of the prompt healing over and perfect circulation of sap that all wounds should be evenly cut and shaped as nearly as possible to the trunk of the tree. In order to secure this condition, the operation of amputating a branch should be com-

menced by making a notch on its lower side (A, Fig. 29). This notch should reach the middle of the

Fig. 29. — Method of preventing injury from the fall of a heavy branch by cutting notches on the lower and upper sides.

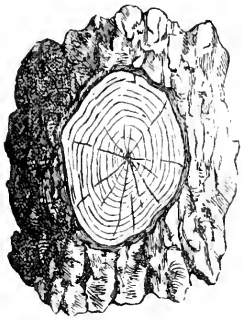

Fig. 30. — Proper appearance of a wound caused by the amputation of a large branch.

branch ; a second notch, B, should then be made on the upper side of the branch, but further from the trunk of the tree than the cut A. By adopting this method all danger, too, of injury to the trunk from the weight of the falling branch tearing away the bark will be avoided.

The operation of amputating a branch will not be complete, whatever method is employed, until the wound is made perfectly smooth (Fig. 30). The workman may do this with his hatchet used as a plane, the handle being held in one hand and the point of the blade in the other.

Use of Coal-tar in Dressing Wounds. — All wounds made on the tree in pruning should be covered with a coat of coal-tar applied with an ordinary painter's brush.

The importance of observing the directions which have been given, however trivial or unimportant they may seem, will be apparent when it is understood that the entire success of the operations of pruning, and of the future production of timber, depends on the proper application of these rules.

It should always be borne in mind that a cut perfectly smooth, and as closely following the line of the trunk as circumstances will permit, is soon recovered with healthy straight-grained wood. In this connection it is well to quote from de Courval, who speaks with the authority of experience, and who has shown with many varieties of trees the correctness of his statements. "A casual examination," he says, "will show that between the surface, which has been cut smooth and treated with coal-tar, and the new tissues which soon cover it, there is only the thinnest crack or fissure analogous to the natural cracks or openings which always appear in wood in seasoning, and which, as is well known, do not diminish its strength, elasticity, or value for all industrial purposes."

In the preceding pages, the general rules which should be followed in pruning forest trees have been given; the special methods applicable to each of the four classes in which trees have been placed according to their age will now be briefly explained.

CHAPTER IV.

METHOD OF PRUNING RESERVE TREES OF DIFFERENT AGES.

Young Trees. — Were it practicable to train young forest trees from their early years in the manner adopted in nurseries to form ornamental specimens, they might, no doubt, be greatly improved, but in planting on a large scale this is of course impossible, and it will be assumed that the young trees destined to serve as reserves have been entirely neglected up to the time of the first cutting over of the plantation.

Where it is the custom to cut over coppice once in every ten or fifteen years, the young reserve trees are often weak and without a proper proportion of lower branches; and thus liable to break down under the too great weight of their tops. If the young trees are too weak to support a ladder, they must be bent down by the hand or by a forked stick, and the weight of the head reduced.

The stem in the case of young trees should, if possible, be furnished with branches for two thirds of its length; and if the leader is dead, or out of

perpendicular, it should be cut off and a vigorous branch taken up to supply its place. This should be fastened in an upright position to the base of the original leader, and if some small branches can be left on this they may be used as withes to hold the new leader in place (Fig. 31).

Fig. 31. — Method of forming a leader on a young tree twelve or fifteen years old.

If the young tree is not strong enough to stand alone, it must be supported by means of a forked stick placed against the side to which it inclines (Fig. 32), a cushion of moss or straw being used to prevent the bark from chafing against the support. It would be better to permanently stake and tie all such feeble young trees, but in a large plantation this is not practicable.

When coppice is allowed to grow for twenty years or more, the young reserve tree is less difficult to manage, has fewer unfavorable conditions to contend against, and has at least gained the advantage of sufficient strength to support a ladder; one of the upright upper branches can, if necessary, be used to form a leader; branches either too long or growing in the wrong direction should be shortened or removed to give to the head the elongated shape required to prevent the excessive

Fig. 32. — Method of propping up a young tree.

development of the lower branches (Fig 33). It may be well to add too, perhaps, that in pruning a young reserve tree twenty years old the main branches should be shortened to about three feet, not including the branchlets left at their extremities to provide the

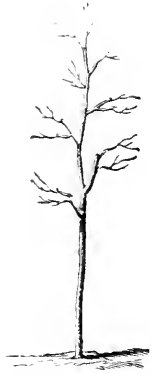

Fig. 33 — Young tree twenty years old correctly pruned.

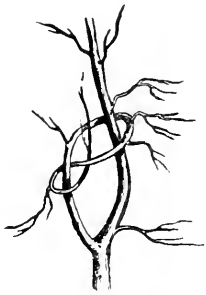

Fig. 34. — Method of forming a leader for a young tree by straightening up a lateral branch.

tree with a sufficient supply of sap. Proportionately larger branches must of course be left on older and larger trees.

Young trees grown in poor or imperfectly drained soil, or under the unfavorable conditions arising from want of light, are often destitute of proper leaders. Generally, as has already been explained, a leader can be formed by straightening up a branch either by the aid of a withe fastened to one of the shortened branches (Fig. 34), or more simply by a small branch twisted round the branch selected for the leader (Fig. 35).

The new leader thus formed will soon begin to grow, and in a short time will entirely change the appearance of a stunted sickly tree (Fig. 36), which, so treated, will become straight and vigorous.

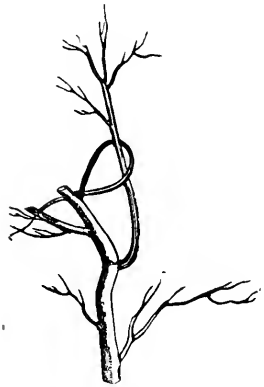

Fig. 35. — Method of forming a leader for a young tree by straightening up a lateral branch.

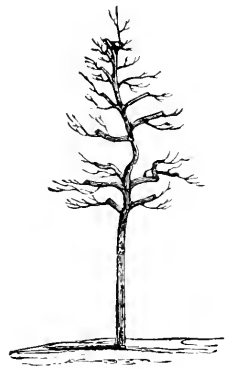

Fig. 36. — Badly grown tree twenty to thirty years old. First pruning

In the case of young trees with a forking main stem, only one of the leaders should be allowed to remain, and the one preserved should be the more nearly upright of the two, without regard to its size or length. A strong strap, fastened to the stump of the suppressed branch, may, if necessary, be used to draw up the leader into a straight position (Fig. 37); when this is necessary proper precautions, however, must be taken to prevent the bark from being injured by the strap.

Often young reserve trees otherwise desirable to preserve are unable, from the unfavorable conditions under which they have grown or on account of injuries re-

ceived from falling trees, to support their own weight, and bend over to the ground. When possible such trees should be straightened and kept upright by the aid of a wire fastened to a neighboring tree. When a wire is used for this purpose, it should be fastened to a branch, and not to the trunk which it might, by its cutting and chafing, easily seriously injure.

Fig. 37. — Removal of one of the leaders of a forked tree.

Should it be found impossible to straighten (Fig. 38) the young tree, it must, unless cut back close to the ground with the loss of several years' growth, be shortened in at some distance (A) above the bend caused by the weight of the head; and above a branch C, which, while furnishing the stump with sufficient sap, may be used as a withe to support in a ver-

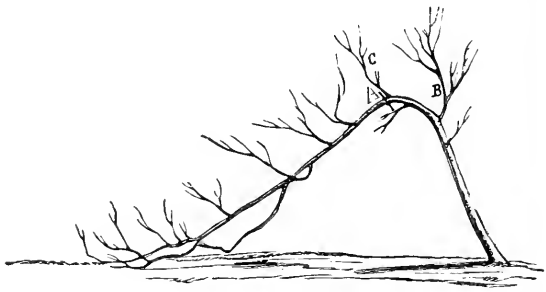

Fig. 38. — Young tree bent to the ground by the weight of its top.

tical position the young branch B, destined to form the new leader. The young tree thus reduced,

and propped up with a forked stick, will in a short time, the conditions being favorable, become a handsome specimen. Such operations are important and should not be neglected, because, as has been explained, it is often desirable to increase the capacity of a plantation to produce timber, by increasing the number of reserve trees in it.

Middle-aged Trees. — As has been explained, in woods frequently cut over, the treatment necessary for young reserve trees is often complicated and difficult; this is not the case with older trees. Trees of the second class constitute the most important part of the forest, and should receive careful pruning. This generally is not difficult, and there are few trees of this

Fig. 39. — Tree forty years old; first pruning

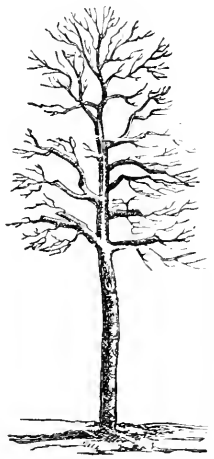

Fig. 40. — Tree sixty or seventy years old, first pruning (second year).

class which may not be either entirely restored, or at least very materially improved, if the necessary sup-

pressions and reductions are operated with judgment and courage (Fig. 39, 40).

The lower branches, which are often unnaturally developed and interfere with the growth of the rest of the tree, should be shortened to establish the proper form of head, while the leader should be treated in the manner already recommended (Fig. 41.)

A tree operated on in this manner will often appear very bare at first; but at the end of a few years the head will have regained a sufficient development.

Fig. 41. — Badly shaped tree of the second class. First pruning.

Old Trees. — It is hardly necessary to explain that old trees require more cautious treatment than younger ones, which may if necessary be entirely remodelled. In pruning an old tree it is not a question of a leader or of increasing the size; and it is only desirable to regulate the shape of the head somewhat, by shortening when necessary such branches as interfere, by their length or position, with the equilibrium of the tree itself, or injure other trees in its vicinity. The heads of old trees should, as far as possible, be reduced to a more or less rounded ovoid, the lower branches being the shortest (Fig. 42, 43).

The main branches should be left six to twelve feet

long, or even longer if they are furnished with sufficient shoots to regulate the flow of sap, although it may be

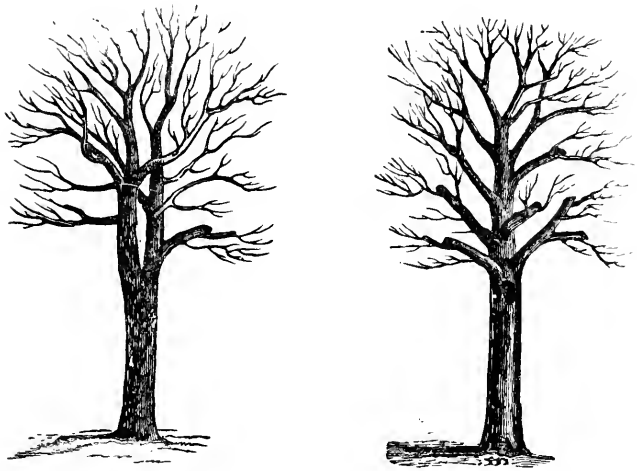

Fig. 42, 43. — Old Oaks, first pruning.

well to repeat that the branches of the Beech should not be shortened, unless it can be done in such a manner as to insure, by abundant foliage at their ends, the supply of sap necessary for the regular development of the tree. In shortening branches, it is difficult, especially for beginners in the art of pruning, to determine the point at which the operation is best performed. Practice and experience soon teach this, however; and, even if a few branches die under the operation, no very serious damage has been done. Two or three large branches can be safely removed at one time from old trees; and, although it is not de-

sirable to make many wounds on the trunk of an old tree, they are less injurious than dead and decaying branches, which produce cavities in the trunk that should be avoided at any cost. The branches of an old tree should not be allowed to interfere with the growth of a younger tree standing near and intended to replace it. In cases of this sort the branches of the old tree should be cut in on the side nearest the young tree much more severely than if it stood by itself (Fig. 44).

Veterans. — If a tree of this class has been properly managed, the length of the trunk should equal one third to one half of its entire height. The method of pruning very old trees does not essentially differ from that recommended for trees belonging to the last class. All dead or dying wood should be carefully removed, and all old wounds not covered with a healthy growth of new wood should be reopened in the manner to be explained hereafter. All branches either disproportionately long or which might interfere with neighboring trees should be shortened; and, should it appear advisable, one or two of the lower branches may be amputated. This can always be done without injury to the tree, and has the advantage of increasing the length of the

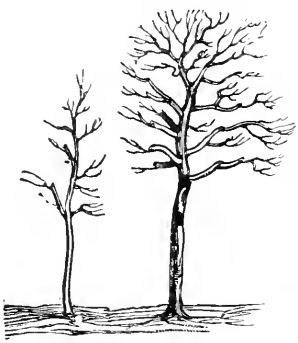

Fig. 44.

trunk and stimulating the growth of the top of the tree (Fig. 45). A tree is never so old that pruning, if practised with judgment and skill, cannot prolong its life and increase its value.

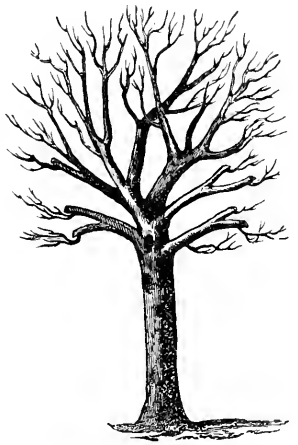

Fig. 45. — Very old tree; first pruning.

The restoration of an old Oak may be cited in this connection. This tree, which stood in a hedge-row, was probably two hundred years old and had suffered terribly from neglect and mutilation. The lower portion of the trunk was covered with the dead stumps of branches (Fig. 46), their numerous protuberances being filled with cavities, and bristling with vigorous shoots. The top had begun to decay, and the tree seemed destined to speedy death. In pruning this tree, it became necessary to make, in the space of a few feet, no less than seven wounds ten to twenty inches wide, in addition to many others of smaller size (Fig. 47). In spite of this heroic treatment the tree improved remarkably in health and vigor; and the numerous wounds made on the trunk by the amputation of dead branches entirely healed over, as may be seen in Fig. 48.

It must be acknowledged that, had this Oak been left in the condition to which neglect had reduced it,

or if nothing beyond lopping off from year to year the young shoots developed along the trunk had been at-

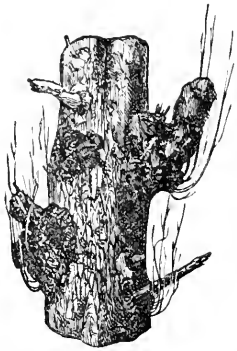

Fig. 46. — Trunk of an Oak injured by neglect and bad pruning.

Fig. 47. — Trunk of the same tree two years after treatment.

tempted, its decay would have been rapid and complete; without pruning it must soon have died without yielding anything more valuable than firewood.

The removal of numerous branches, for the purpose of restoring vigor to a decrepit tree, may seem opposed to what has already been stated in regard to the functions of leaves in elaborating plant food; and it might be argued that pruning must be injurious, because, in shortening or removing a branch, some of the leaf organs essential to the growth of the tree must also be destroyed. Such an argument is based on a popular error of very general acceptance.

It is often claimed that the healthy growth of a plant depends on the number of its leaves. It is

not, however, the number of leaves, but the total superficial area of leaf surface, which determines the vigor of growth of the plant. An ordinary practice of the nurseries affords a familiar example.

Fig. 48. — Old Oak restored to vigor by numerous large amputations.

A seedling tree several years old bears, perhaps, twenty or thirty leaves; its stem is not thicker than a quill, and it does not grow vigorously. If, however, this plant is cut down to the ground in the spring, it will be replaced, in four or five months, by a stout vigorous shoot often an inch in diameter, but carrying perhaps only six or eight very large leaves; the superficial leaf area of the new plant is larger, although the actual number of its leaves may be considerably smaller. This is what good pruning accomplishes; i. e., while it may reduce the number of leaves on a tree, it increases their capacity to elaborate plant food through increased superficial area. Scientific pruning provides too, it must be remembered, an abundant leaf area on the branchlets left at the extremities of all shortened branches, and arranges the branches themselves in a manner to expose the largest surface of foliage to the oblique rays of the sun. It will be seen, then, that this apparent contradiction between the practice and theory of pruning

does not exist; and that pruning, while it reduces, perhaps, the actual number of leaves on a tree, really increases its vigor by furnishing the largest possible leaf surface in the smallest possible space.

CHAPTER V.

THE TREATMENT OF OLD WOUNDS. — CAVITIES IN THE TRUNK. — THE REMOVAL OF SHOOTS.

Bark once injured or loosened can never attach itself again to the trunk; and whenever wounds, abrasures, or sections of loose bark exist on the trunk of a tree, the damaged part should be cut away cleanly as far as the injury extends. Careful persons have been known to nail on to a tree a piece of loosened bark, in the hope of inducing it to grow again, or at least of retaining on the young wood its natural covering. Unfortunately the result produced by this operation is exactly opposite to that intended. The decaying wood and bark attract thousands of insects, which find here safe shelter and abundant food; and, increasing rapidly, hasten the death of the tree.

In such cases, instead of refastening the loosened bark to the tree, it should be entirely cut away, care being taken to give the cut a regular outline, especially on the lower side; for, as has been already explained, if a portion of the bark (A, Fig. 49),

even if adhering to the wood, is left without direct communication with the leaves, it must die and decay. A coating of coal-tar should, of course, be applied to such wounds.

Fig. 49.

Loosened Bark. — It is necessary to frequently examine the lower portions of the trunk, especially of trees beginning to grow old; for here is often found the cause of death in many trees, in the large sheets of bark entirely separated from the trunk. This condition of things, which often cannot be detected except by the hollow sound produced by striking the trunk with the back of the iron pruning knife, arrests the circulation of sap, while the cavity between the bark and the wood furnishes a safe retreat for a multitude of insects, which hasten the destruction of the tree. The dead bark should be entirely removed, even should it be necessary in so doing to make large wounds. Attention, too, should be given to injuries to the bark caused by the fall of neighboring trees. These may remain hidden for years, and are often only detected by the peculiar sound produced by a blow of the pruning knife. Cases of this nature require the treatment recommended for the last class.

Cavities in the Trunk. — Very often when a tree has been long neglected, the trunk is seriously injured by cavities caused by the decay of dead or broken branches. It is not claimed that pruning can remove

defects of this nature: it can with proper application, however, arrest the progress of the evil, and in such cases should always be resorted to. The edge of the cavity should be cut smooth and even; and all decomposed matter, or growth of new bark formed in the interior, should be carefully removed. A coating of coal-tar should be applied to the surface of the cavity, and the mouth plugged with a piece of well-seasoned oak, securely driven into place. The end of the plug should then be carefully pared smooth and covered with coal-tar, precisely as if the stump of a branch was under treatment. If the cavity is too large to be closed in this manner, a piece of thoroughly seasoned oak-board, carefully fitted to it, may be securely nailed into the opening and then covered with coal-tar. It is often advisable to guard against the attacks of insects, by nailing a piece of zinc or other metal over the board, in such a way that the growth of the new wood will in time completely cover it.

These operations resemble, if such a comparison is admissible, the fillings performed by dentists, and with the same object, — to check the progress of decay.

A glance at Fig. 50 shows what takes place when cavities in the trunks of trees are treated in the manner recommended. On the right a cavity treated in this manner is shown. New layers of healthy straight-grained wood have already formed; the circulation of sap is regular and healthy; and the tree is entirely restored to health. On the left an old neglected

wound may be seen. These instructions are equally applicable to the treatment of large wounds, caused by the fall of branches broken by the wind, or by any other cause (Fig. 4).

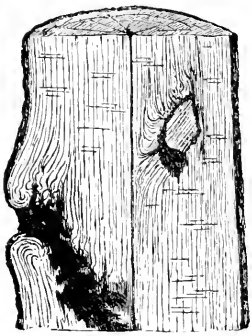

Fig. 50. — On the right an old cavity properly treated and stopped: and recovered at the end of twenty years with sound straight-grained wood. On the left a wound of the same sort abandoned and causing decay to penetrate to the heart of the tree.

Removal of Shoots. — During the spring following the operation of pruning, or even sooner if the tree has been pruned during the active flow of sap, numerous shoots are developed along the trunk, and especially along the lower portion of the branches. The number of such shoots varies greatly in different trees; and although they are not entirely the result of pruning, for such shoots appear on trees which have never been pruned, still it is clear that their number and vigor bear a certain relation to the number and size of the branches removed in pruning, and that the more severely a tree is pruned the more of these shoots it will develop.

The removal of these lateral shoots is essential to a healthy growth of the tree, and may be easily accomplished with a little pruning hook (Fig. 51), so light that it can be used by a child if necessary. The sharp blade is worked up and down in the direction of the grain of the wood; the little hook rounded at the end is also sharpened, and can be used in cutting

and pulling down shoots not entirely severed by the blade.

The following method may be adopted in removing these young shoots. When the second or August growth of the tree is finished, and the young shoots are still soft and tender, that is in August and September, a workman armed with two pruning hooks, fastened on long tough handles of different lengths, and carrying his pruning knife in his belt, commences the operation by cutting off all the shoots within reach of his knife.

Fig. 51. — Pruning hook.

This is continued first with the short and then with the long-handled pruning hook, with which he will be able to reach to the top of the trunk of an ordinary-sized tree. In the case of very tall trees it will, of course, be necessary to use a ladder; and, although this will make the removal of the shoots a longer and more expensive operation, it should not on this account be neglected. The presence of a few shoots, along the upper part of the trunk of a large tree, does not materially interfere with its growth; their proximity to large branches, by which they are necessarily shaded and overtopped, checks their growth and prevents any great injury to the tree. As a general rule, however, all such shoots developed on the trunk below the branches should be removed, except from very young trees, insufficiently supplied with foliage, or when less than one third of

their height is regularly furnished with branches. In such cases several shoots should be left to supply the place of branches and to regulate the flow of sap (Fig. 52).

Fig. 52. — Preservation of shoots on the stem of a young tree destitute of sufficient branches.

It is often desirable to make two operations of lopping these shoots. Those on the lower portion of the trunk may be cut during the first half of July; while those higher up on the tree may be left until September, to aid the flow of sap and hasten the healing of the wounds made in removing those first cut.

The removal of these shoots is one of the most important operations connected with scientific pruning, and it should be carefully performed as long as they continue to appear, that is during two or three or at most four years if the tree was skilfully pruned at first.

CHAPTER VI.

SEASON FOR PRUNING. — THE USE OF COAL-TAR.

Season for Pruning. — The most favorable season of the year for pruning is the autumn, when the days are still long and pleasant. The sudden and severe frosts, however, which often occur at this season of the year, are dangerous, and in some instances have a tendency to cause decay in freshly made wounds. In winter the days are too short, and often too stormy, to allow continuous work of this nature; while the loss of sap which occurs when trees are pruned in the spring, although considerably checked by the use of coal-tar, is probably rightly considered injurious. The leaves interfere with pruning during the summer months when, too, there is danger of the workmen inflicting injury on the growing tender shoots of neighboring trees; but a tree may be pruned at any season of the year, and the best time for pruning is that which is most convenient, and when it can be most cheaply performed.

All trees, whatever the nature of the soil in which they grow, may be advantageously and profitably

pruned, with the exception perhaps of trees growing on very poor and barren soil. These, as a general rule, can produce nothing more valuable than fuel, and hardly justify the cost and labor of pruning.

The Use of Coal-tar. — Coal-tar, a waste product of gas works, is a dark-brown imperishable substance with the odor of creosote. It can be applied with an ordinary painter's-brush, and may be used cold, except in very cold weather, when it should be slightly warmed before application. Coal-tar has remarkable preservative properties, and may be used with equal advantage on living and dead wood. A single application without penetrating deeper than ordinary paint forms an impervious coating to the wood cells, which would without such covering, under external influences, soon become channels of decay. This simple application then produces a sort of instantaneous cauterization, and preserves from decay wounds caused either in pruning or by accident. The odor of coal-tar drives away insects, or prevents them, by complete adherence to the wood, from injuring it. After long and expensive experiments the director of the Parks of the City of Paris finally, in 1863, adopted coal-tar in preference to other preparations used for covering tree wounds, as may be seen in all the principal streets of the capital.

Objections to other Preparations. — Efforts have been made for a long time to discover some method of covering the wounds inflicted on trees, either accidentally or by the hands of man. The remedy usually

recommended from time immemorial is the ointment of St. Fiacre, a mixture of loam and cow dung. Various preparations, too, used in grafting, and having rosin, wax, and grease, as their basis, have at different times been very generally recommended for this purpose. These preparations are expensive; and, as they must be applied hot, it is not practicable to use them on a large scale. Their use, too, is attended with serious difficulties. As the new growth of wood spreads over the wound, these thick coatings are either broken or pushed aside bodily, according to the power of resistance of the material used; and the wood is again exposed and a safe retreat for injurious insects prepared.

One coat of coal-tar is sufficient for wounds of ordinary size; but, when they are exceptionally large, a second coat may, after a few years, be well applied. In warm countries, like the south of France, the great heat of summer renders coal-tar so liquid that it is often impossible to properly treat wounds made at that season. In such cases another coat should be applied during the following winter.

Effects of Coal-tar on the Elm. — The effect of coal-tar on the Elm is not always as satisfactory as upon other forest trees, such as the Oak, Ash, Sycamore, Birch, Maple, etc. The application of a coat of coal-tar on all of these gives at once to the wound a hard firm surface; on the Elm, however, it does not always adhere firmly, owing to the formation on the surface of the wound of the water blisters common to this

tree. In such cases the coal-tar which does not adhere firmly should be rubbed off and another coat applied to the wound.

Employment of Coal-tar in protecting Young Plantations against Animals. — Coal-tar may be used with excellent effect in protecting young plantations from the attacks of rabbits, and other game, or such domestic animals as goats and sheep. Satisfactory results have been obtained too, from the use of coal tar in protecting young trees from horses, which often take special delight in tearing off the entire bark from certain kinds of trees, particularly Elms and Poplars. This is not, however, always a safe or desirable remedy, as it necessitates covering a large part of the stem, and this is often fatal to the tree either by producing asphyxia, from which trees treated in this manner are liable to suffer, or, perhaps, by the action of the powerful acid contained in coal-tar itself, which, used in large quantities, might perhaps affect the sap.

Employment of Coal-tar on Fruit Trees. — It is for this reason that the application of coal-tar should not be made except with considerable caution in the treatment of wounds on drupacious fruit trees (Cherries, Peaches, Plums, etc.), and especially on the Plum-tree. It has often been observed that the bark of fruit trees of this class have suffered from the application of coal-tar. This is not the case, however, with Pome-bearing trees (Apples, Pears, etc.); to these coal-tar may be applied with perfect safety.

It must not be supposed from these remarks that

coal-tar cannot be used on the Plum, or other trees of its class. On the contrary, there is no substance which can replace it in the treatment of large wounds on these trees; but it should be used cautiously, especially in the case of young trees, and should not be allowed to needlessly run down the trunk; and it is well to remember that the more active a remedy, the greater the care necessary in its application.

CHAPTER VII.

SOFT WOODS. — POPLARS. — CONIFERS.

Soft Woods. — Woods with little density or strength are called "soft woods" or "white woods," in distinction from hard woods, such as oak, elm, ash, etc. Such woods are easy to work and in great demand for many purposes. The trees yielding wood of this sort grow often three or four times as rapidly as hard-wood trees, and are therefore more profitable to cultivate. To this class belong many trees with deciduous foliage such as the Poplars, Willows, Lindens, etc., and most conifers. The general rules for pruning are applicable to trees of this class, and it is only necessary to say a few words in regard to the treatment proper for Poplars and Conifers.

Poplars. — The Poplars, owing to their rapid growth and the excellent quality of the wood yielded by them, constitute a group of considerable interest. The growth of these trees is often so rapid that it is practicable to make the length of their trunks equal one third to one half of the entire height of the tree, and thus greatly increase their value for industrial pur-

poses. The large branches of trees of this family are very brittle, and are easily broken by wind or ice, and should be shortened in the manner already explained for hard-wood trees.

Conifers. — These trees, which are generally gregarious and form extensive forests, are valuable subjects for Sylviculture, on account of the readiness with which they reproduce themselves from seed, and because they admirably prepare the soil to produce hard woods and especially the Oak. Of the two operations of pruning — the cutting close to the trunk, and the shortening of branches — the second need not often be applied to the natural pyramidal form of Firs and Spruces: for these trees nothing is necessary beyond removing, when possible, dead or dying branches.

The Pines, however, when not growing under the conditions peculiar to them, that is crowded together, often develop enormous branches, which greatly interfere with the beauty and the value of the trunk, the only portion of the tree possessed of any value. The rules laid down for shortening the branches of Oaks and other deciduous trees are, in case of necessity, applicable to Pines; that is, one third or one half of the length of the branches may be safely cut away. It is essential, however, to preserve at the end of the shortened branches an abundant supply of foliage as the branch of a coniferous tree deprived of leaves is more certain to perish than the branch of a deciduous tree under similar circumstances. A Pine may in this way be made to assume the natural form it would have

had if grown under normal conditions; the trunk lengthens and thickens regularly, giving to the tree an economic value for many purposes of construction, and especially for the masts and spars of vessels.

As a Pine grows, the lower branches die and dry up. The resin with which these are impregnated prevents their decay; and these dead branches, embedded in the new wood form the knots which interfere with the growth of the tree and produce holes in the boards and planks cut from it. Such defects can be greatly diminished by cutting off all dead or dying branches close to the trunk; while a coat of coal-tar will prevent or reduce the flow of resin from the wound.

The practice of leaving a short stump to an amputated branch, adopted by some persons to prevent the loss of sap, although less objectionable in the case of coniferous trees, should never be adopted. Such stumps must be cut again the following year close to the trunk, or cushions of wood will form about their base, covering the trunk with protuberances (Fig 53). These greatly injure the appearance and value of the tree, and necessitate, should it be found desirable to remove later such excrescences, wounds two or three times as large as an original cut close to the trunk would have made.

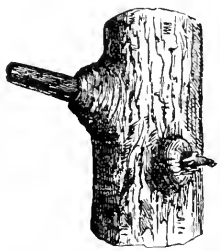

Fig. 53. — Effect on the Pines of leaving the stump of an amputated branch.

The custom of pruning Pines is very general in France, and is often carried to excess. The removal

of all branches, with the exception of a few at the top of the tree, must greatly interfere with the growth in diameter of the trunk; and healthy branches should not be removed for the sake of creating a clean trunk of more than one half or at the most two thirds of the entire height of the tree. The general rule of pruning already explained in the case of deciduous trees, and which establishes a proportion between the number of branches which should be removed and the size of the tree, might with advantage be more generally applied in the treatment of Pines.

SUMMARY OF THE PRINCIPAL OPERATIONS OF PRUNING.

1. **Young Tree.** — The length of the trunk should equal one third of the entire height of the tree. The head should be elongated ovoid in form, with the centre of gravity sufficiently low to keep the tree upright. The lower branches, shortened to prevent excessive development of the leader, should afford sufficient leaf surface to elaborate the sap necessary to ensure rapid growth.

2. **Middle-aged Tree.** — The trunk should equal about two fifths of the entire height of the tree. The head should be a shorter ovoid than that recommended for trees of the first class. A vertical branch upright on the trunk, or any part of the trunk, should if necessary be made to replace the original leader ; all other vertical branches should be shortened to encourage the growth of the leader. If a single branch cannot be converted into a leader, a regular well-balanced head may be made with several branches. As the tree grows some of the lower branches should be removed to increase the length of the trunk. Not more than three or four branches should be removed in any one year. The amputation of a branch should be carefully performed; the cut should be made perfectly smooth and rounded, to coincide with the form of the trunk, thus bringing its whole circumference into direct communication with the leaves by means of the layer of living cells. These distribute the descending sap, which alone forms the new wood destined in time to cover over the wound. Wounds made in this manner heal in a short time; but, to preserve them from external influences which induce decay, they should be covered as soon as made with a coat of coal-tar. All dead or dying branches, and all stumps of branches, should be cut off, and the wounds treated in the same manner.

3. **Old Tree.** — The length of the trunk should nearly equal one half the entire height of the tree. All decayed portions of the tree should be carefully removed. A few of the lower branches may be removed or shortened.

4. **Veteran.**—The tree having ceased to grow the head gradually becomes flat-topped. Such lower branches as might, by their too great size, injure younger trees growing in the vicinity should be removed. Very old trees should be treated in the manner recommended for those of the third class, although requiring greater care and judgment in their management.